CIRAD
ATP 96/21

SÉMINAIRE GESTION RAISONNÉE DES RÉSISTANCES DES PLANTES AUX PATHOGÈNES

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MONTPELLIER 11-12 SEPTEMBRE 1997

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Lutte génétique contre la maladie sud américaine de l 'hévéa due à *Microcyclus ulei* (SALB).

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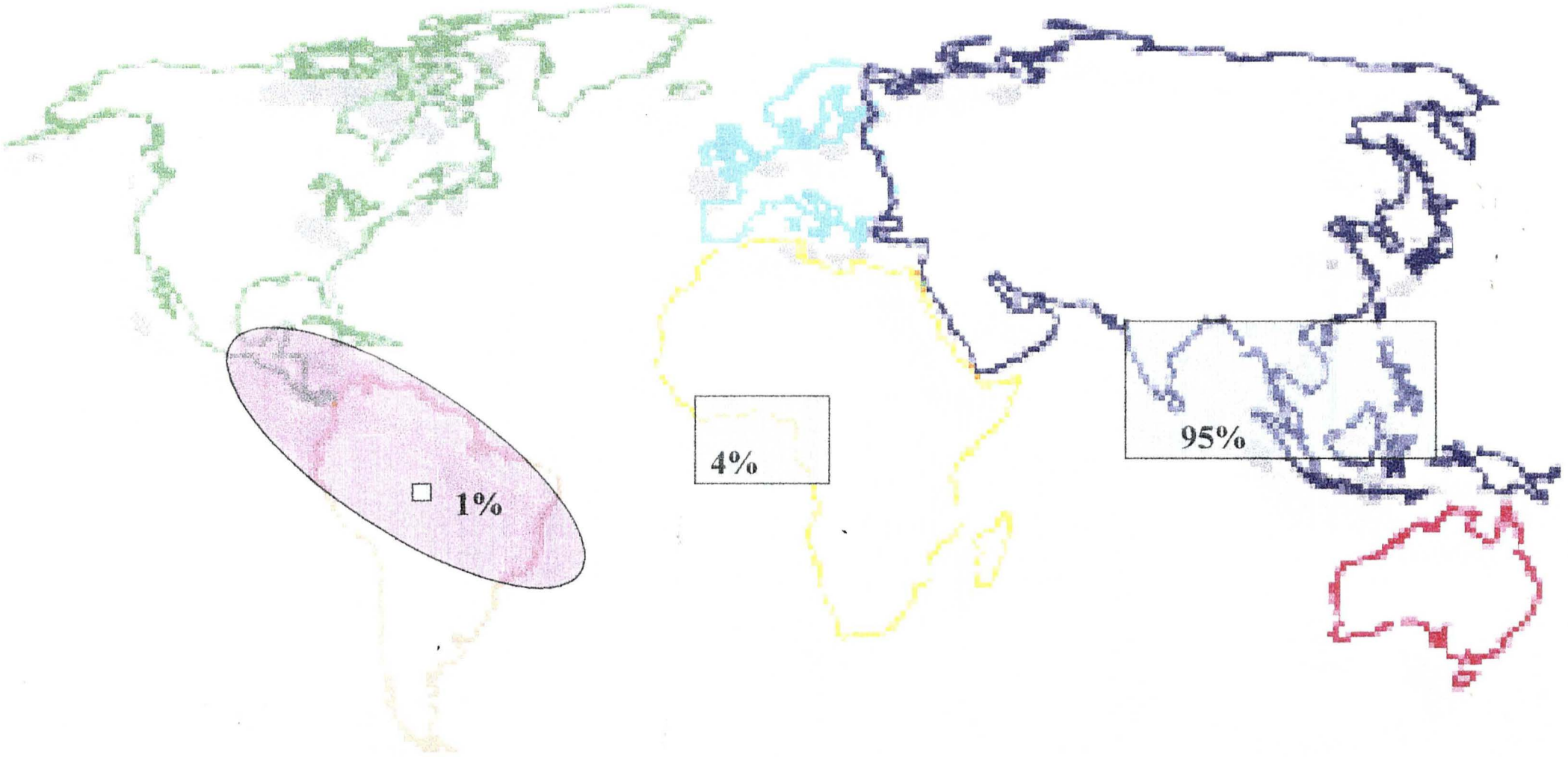
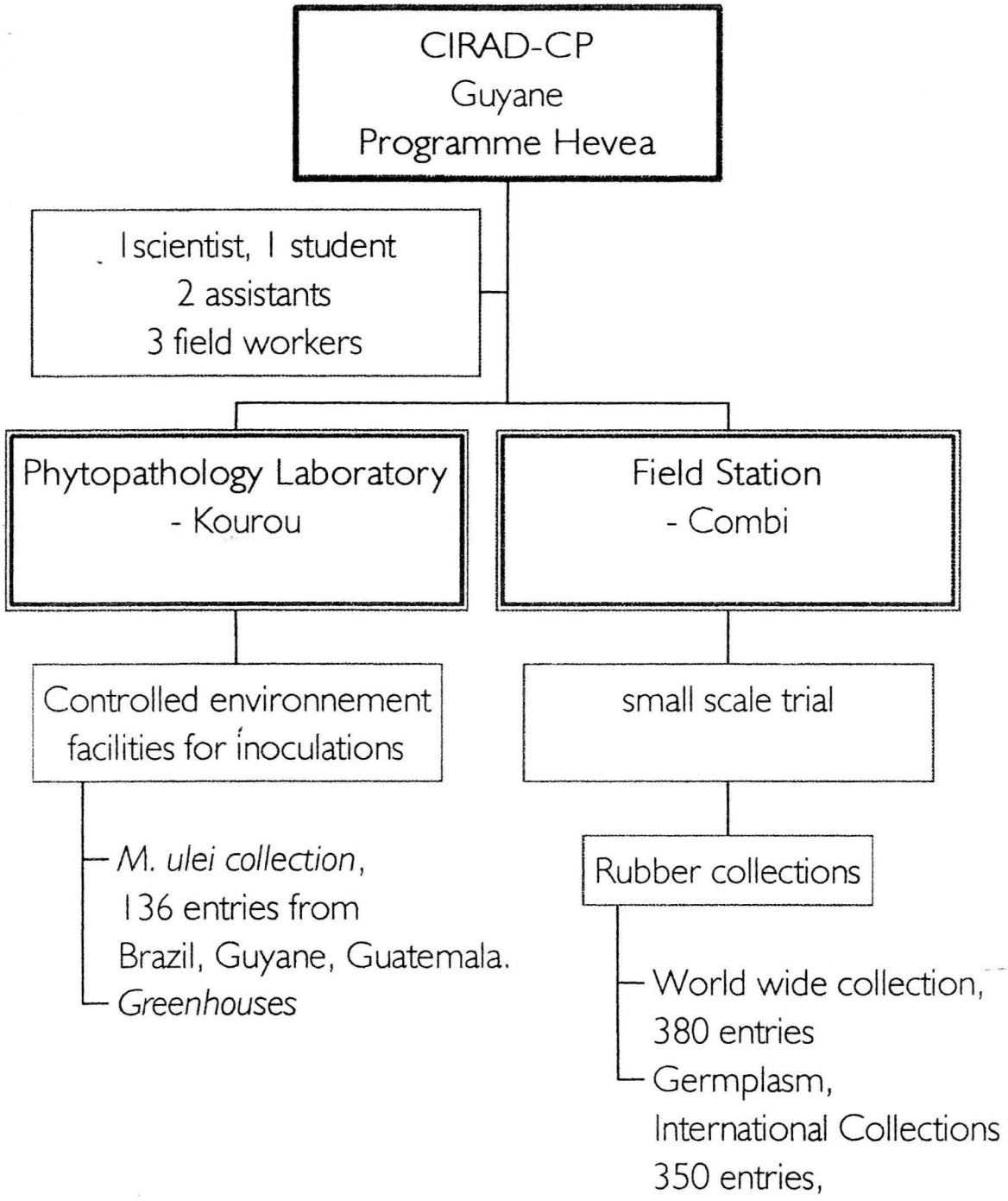
Aire d 'extension de M. ulei et zones de culture de l 'hévéa




CIRAD-CP
Guyane
Programme Hevea
1 scientist, 1 student
2 assistants
3 field workers
Phytopathology Laboratory
- Kourou
Field Station
- Combi
Controlled environnement
facilities for inoculations
small scale trial
M. ulei collection,
136 entries from
Brazil, Guyane, Guatemala.
Greenhouses
Rubber collections
World wide collection,
380 entries
Germplasm,
International Collections
350 entries,

Objectif:

- Amélioration génétique et sélection pour une résistance durable

Programme d 'études:

- Caractérisation et mesure de la diversité des populations de *M. ulei*
- Caractérisation de la résistance de l 'hôte
- Cartographie génétique de l 'hévéa et marqueurs de résistance

Sites des travaux:

- Guyane, phytopathologie (CIRAD),
- Itubera, (Bahia, Brésil), phytopathologie (Michelin),
- Rondonopolis (M.G, Brésil), pgr. de sélection (CIRAD, Michelin)
- Montpellier, Agetrop (CIRAD)

Research Programme:

Goals: Selection for « durable » resistance

Avoid to select « only » genes with major effect (hypersensitivity)

Select for partial resistance,
for minor genes

Means: Field trials,

Controlled environnement trials,

Genetic mapping for resistance (M.A.S)

M. ulei population diversity

Study on differential host range: 10 clones

- Ian 710
- Fx 4098
- Fx 3925
- Fx 25
- Ian 3087
- Ian 717
- Fx 985
- Fx 3899
- Fx 2804
- Fx 2261

More than 140 strains tested in standard conditions.

Results:

- the number of virulence expressed by *M. ulei* is high,
- accumulation of virulence factors is frequent

Conclusion: The result confirms the ability of *M. ulei* to overcom complete resistance expressed in Rubber.

Souche	Date	Ian_710	Fx_4098	Fx_3925	Fx_25	Ian_3087	Ian_717	Fx_985	Fx_3899	Fx_2804	Fx_2261	Vir
pem 3	01/12/1994	+	+	+	+	+	+	-	+	+	-	8
gu 1	01/12/1994	+	+	+	+	+	+	-	+	+	-	8
gu 2	01/12/1994	+	+	+	+	+	+	-	+	+	-	8
gu 3	01/12/1994	+	+	+	+	+	+	-	+	+	-	8
gu 4	01/12/1994	+	+	+	+	+	+	-	+	+	-	8
pem 1	01/12/1994	+	+	+	+	+	+	-	+	-	-	7
ftp 25	01/12/1994	+	+	+	+	-	+	-	+	+	-	7
tr 1	01/12/1994	+	-	+	+	+	+	-	+	+	-	7
g 29	01/02/1992	+	+/-	+	+	+	+/-	-	+	+	-	6*
ftp 20	01/12/1994	+	+	+	-	-	+	-	+	+	-	6
ftp 12	01/12/1994	-	-	+	+	+	+	-	+	+	-	6
g 9	01/01/1992	+	+	+	+	-	-	+	*	-	-	5*
g 22	01/01/1992	-	+	+	-	+	+	-	-	-	*	4*
ftp 6	01/12/1994	+	+	-	+	-	-	+	-	-	-	4
ftp 13	10/08/1995	+	+	-	+	-	-	-	+	-	-	4
g 28	01/01/1992	+	+	+	-	*	-	*	-	-	*	3*
g 5	01/01/1992	+	-	-	-	+	+/-	+	*	-	-	3*
g 2	01/01/1992	-	+	*	-	+	-	+	*	-	-	3*
g 35	01/01/1992	-	+	-	-	+	-	+	-	*	*	3*
ftp 17	01/12/1994	+	+	-	+	-	-	-	-	-	-	3
g 27	01/01/1992	+	-	-	+	-	-	+	-	-	-	3
una 9m	28/08/1995	-	+	-	-	-	+	+	-	-	-	3
g 15	01/01/1992	+	-	-	*	+	-	*	-	-	*	2*
g 14	01/01/1992	-	+	*	-	-	*	+	*	-	-	2*
g 11	01/01/1992	-	-	+	*	-	-	*	+	-	*	2*
una 8m	19/10/1995	+	+	-	-	-	-	-	-	-	-	2

Field trial

Combi 8- (Jan. 1995)

- 25 clones; 6x5 repetitions; (2 ha)
- monthly evaluation of foliar stages C and D
  - * *M. ulei,*
  - * *C. gloeosporioides,*
  - * *P. uberi*.
- Factorial Analysis of Correspondances (FAC)

Results:

- 3 different field patterns: susceptible,
  intermediate,
  resistant
- influence of clones origine
- field resistance

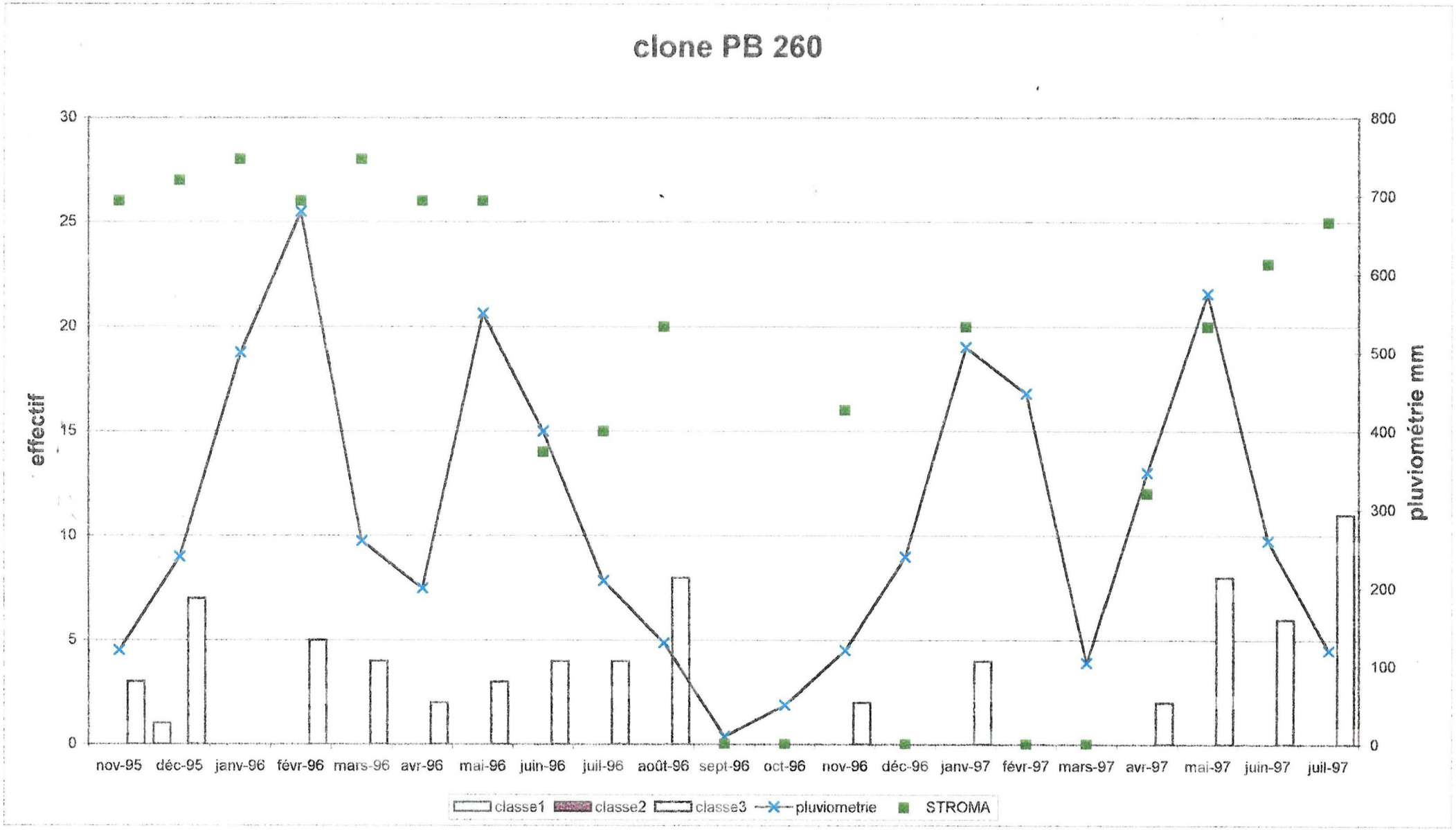
Next step: analysis of resistance in controlled environnement

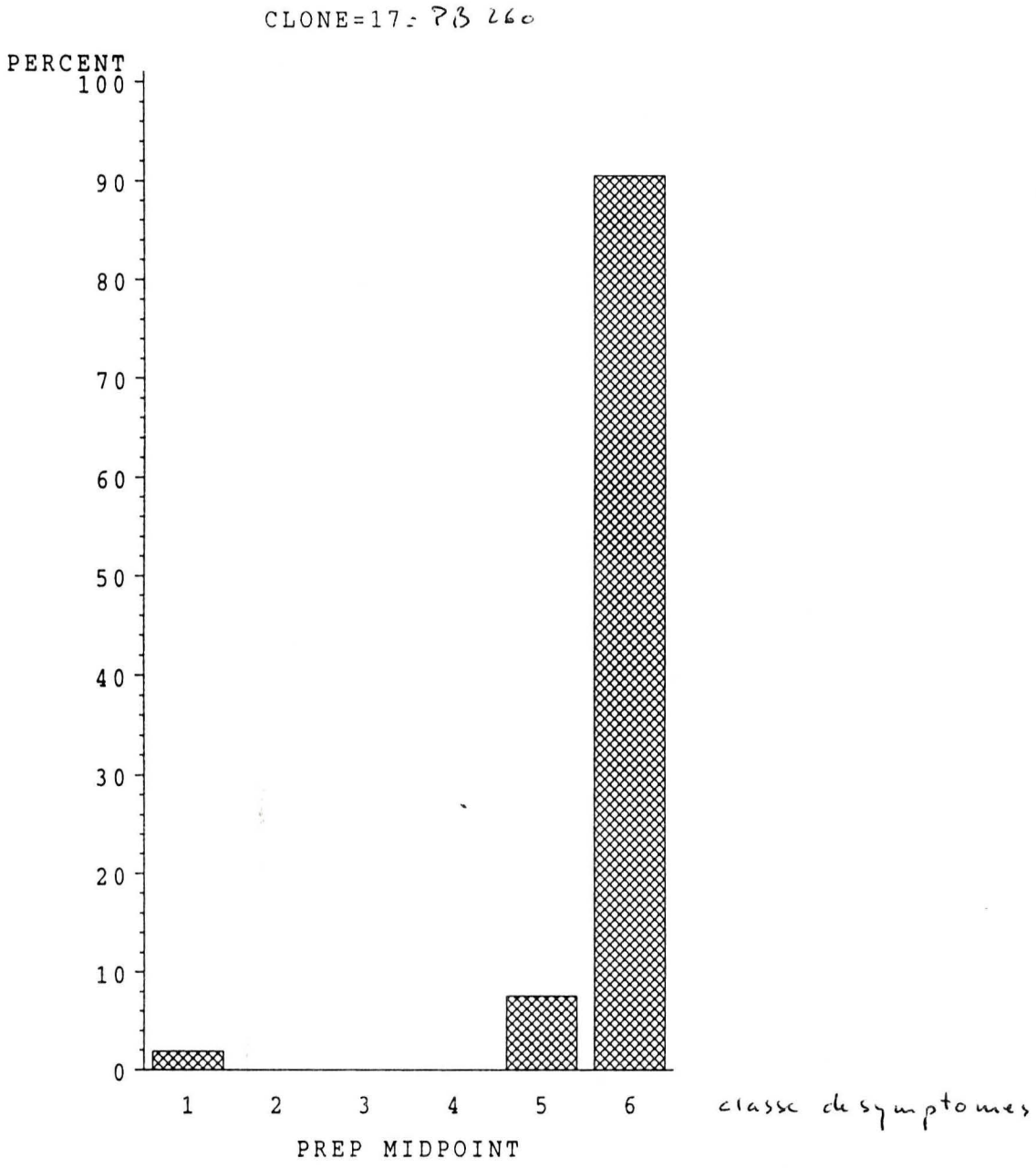
COMBI 8 TRIAL (January 1995)

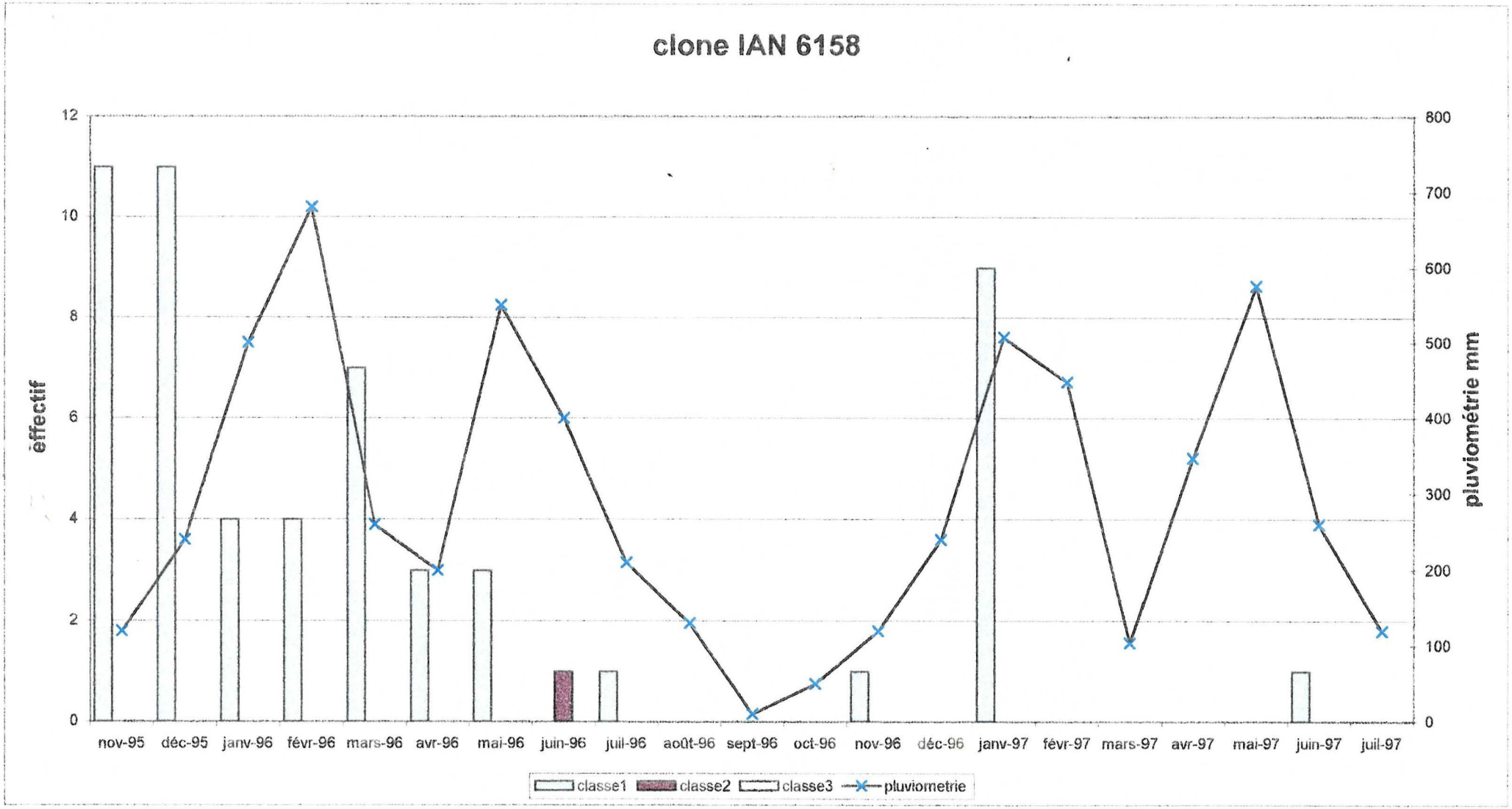
NUMBER	CLONES	SOURCE
1	AC/F/6A 36/376	AMAZONIAN
2	AC/F/6A 36/485	AMAZONIAN
3	AC/S/08/40	AMAZONIAN
4	F 4512	AMAZONIAN
5	FX 2784	WICKHAMxAMAZONIAN
6	FX 3864	WICKHAMxAMAZONIAN
7	GU 86	WICKHAMxAMAZONIAN
8	IAN 6158	WICKHAMxAMAZONIAN
9	IAN 873	WICKHAMxAMAZONIAN
10	IRCA 427	WICKHAMxAMAZONIAN
11	IRCA 564	WICKHAMxAMAZONIAN
12	IRCA 617	WICKHAM
13	IRCA 733	WICKHAM
14	IRCA/GY 5	WICKHAMxAMAZONIAN
15	IRCA/GY 7	WICKHAMxAMAZONIAN
16	MDF 114	AMAZONIAN
17	PB 260	WICKHAM
18	RII 118	WICKHAM
19	RII 208	WICKHAM
20	RO/JP/3 22/374	AMAZONIAN
21	RO/JP/3 22/418	AMAZONIAN
22	RO/JP/3 22/44	AMAZONIAN
23	RRIM 729	WICKHAMxAMAZONIAN
24	RRIM 806	WICKHAM
25	RRIM 926	WICKHAM

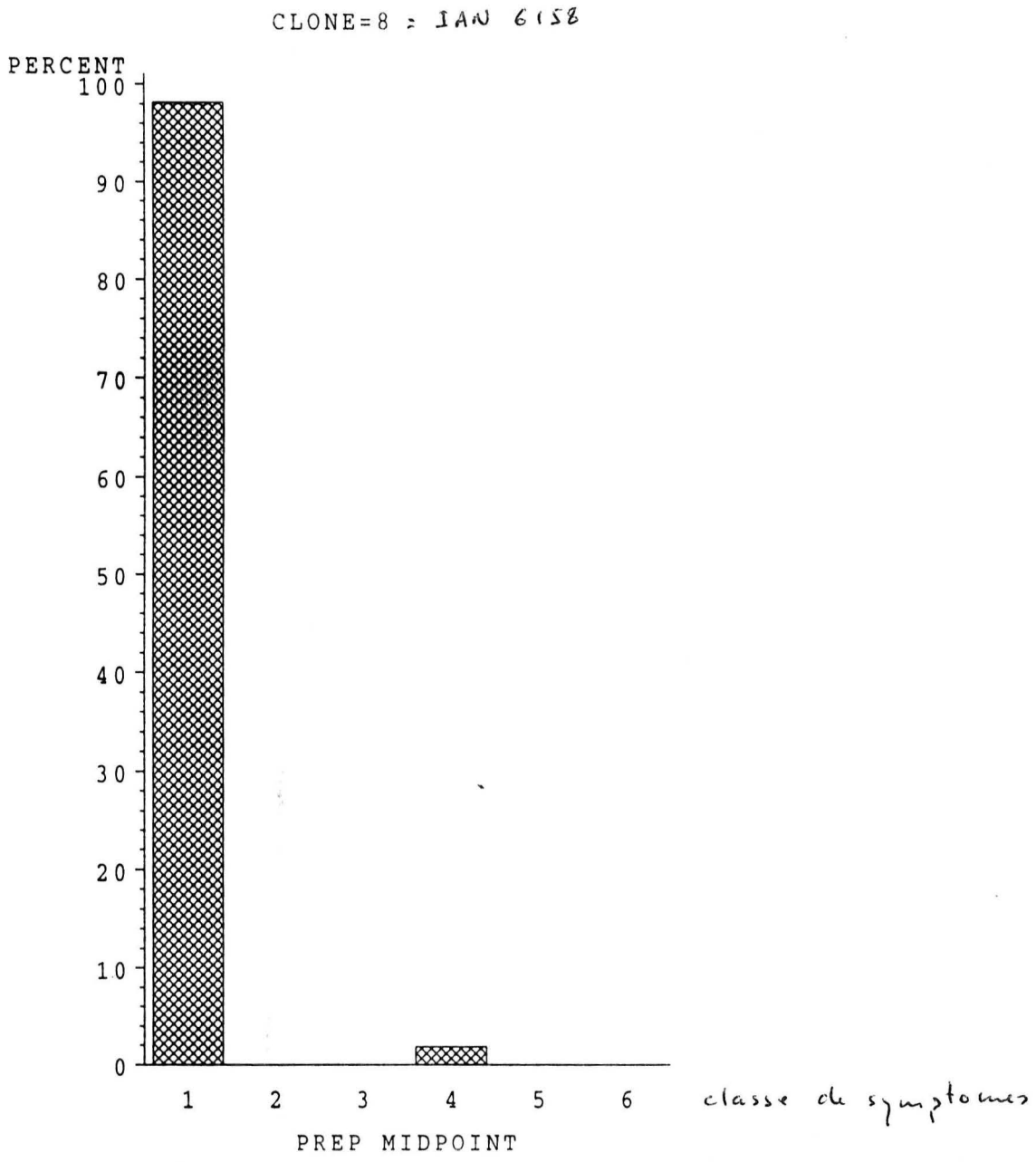
NOTATION OF ASEXUAL SPORULATION (FOLIAR STAGE C)

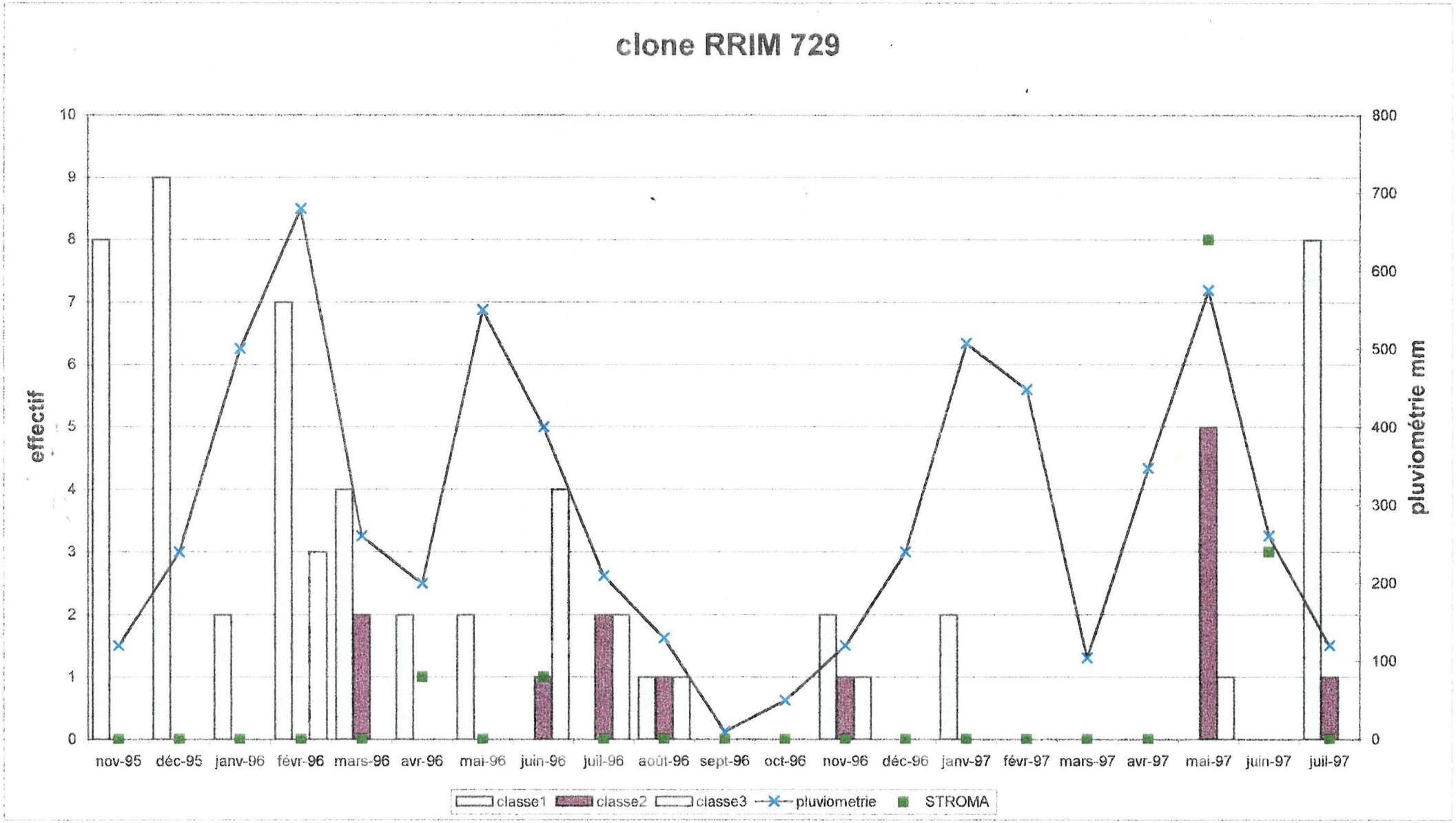
	NEW NOTATION	JUNQUIERA NOTATION	SYMPTOMS
1. Without sporulation	1	1 to 4	Chlorotic and necrotic lesions, without sporulation.
	2	5	Non-chlorotic and non-necrotic lesions, without sporulation.
2. Partial sporulation	3	6 to 7	Weak and heterogenous sporulation.
	4	8 to 9	Weak and homogenous sporulation.
3. Strong sporulation	5	10, 11 and 13	Strong sporulation on the abaxial side of the leaf.
	6	12 and 14	Strong sporulation on both sides of the leaf.


clone PB 260
effectif
pluviométrie mm
30
25
20
15
10
5
0
800
700
600
500
400
300
200
100
0
nov-95
déc-95
janv-96
févr-96
mars-96
avr-96
mai-96
juin-96
juil-96
août-96
sept-96
oct-96
nov-96
déc-96
janv-97
févr-97
mars-97
avr-97
mai-97
juin-97
juil-97
classe1
classe2
classe3
pluviometrie
STROMA

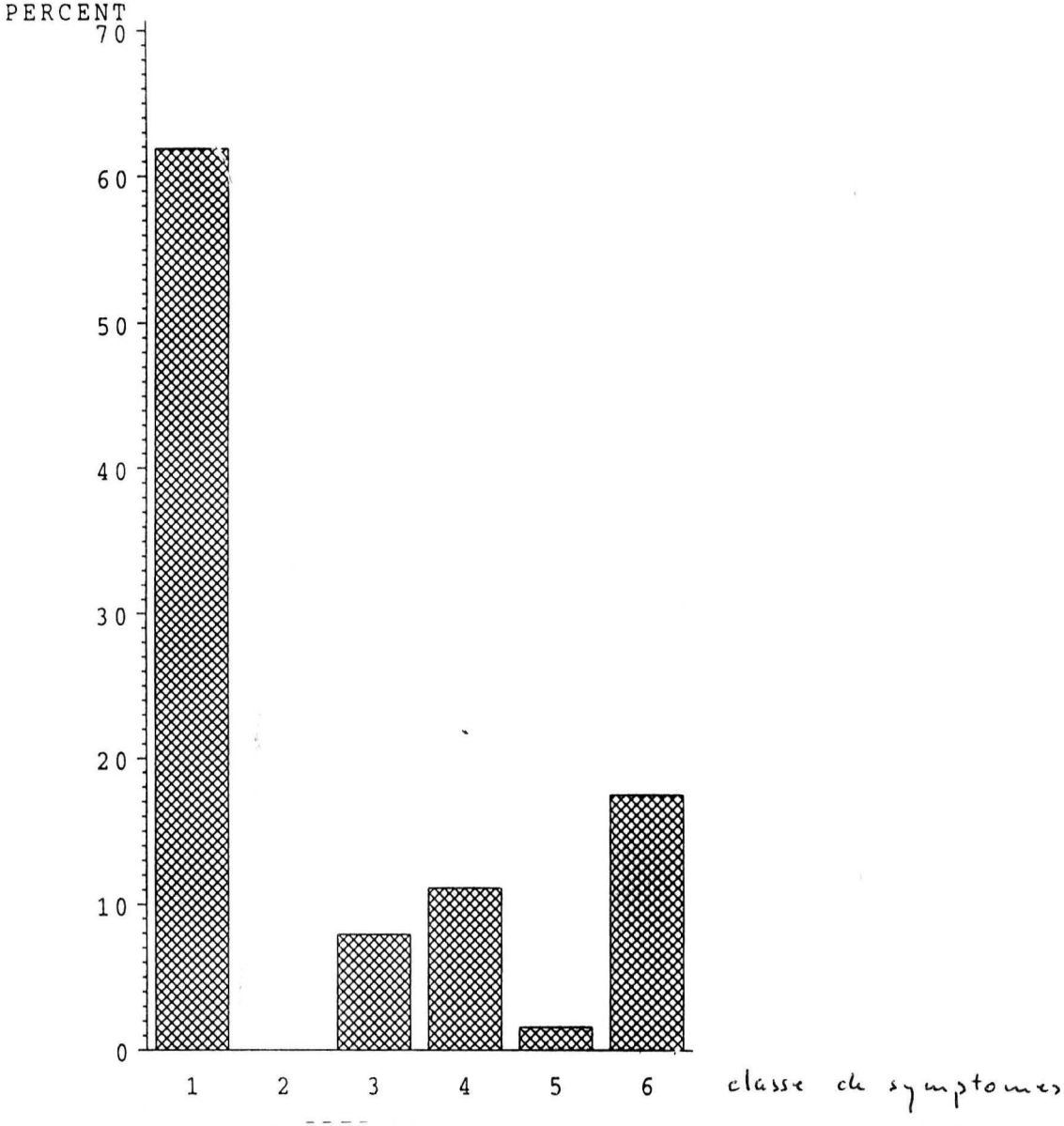

CLONE=17 : PB 260
PERCENT
100
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
classe de symptomes
PREP MIDPOINT

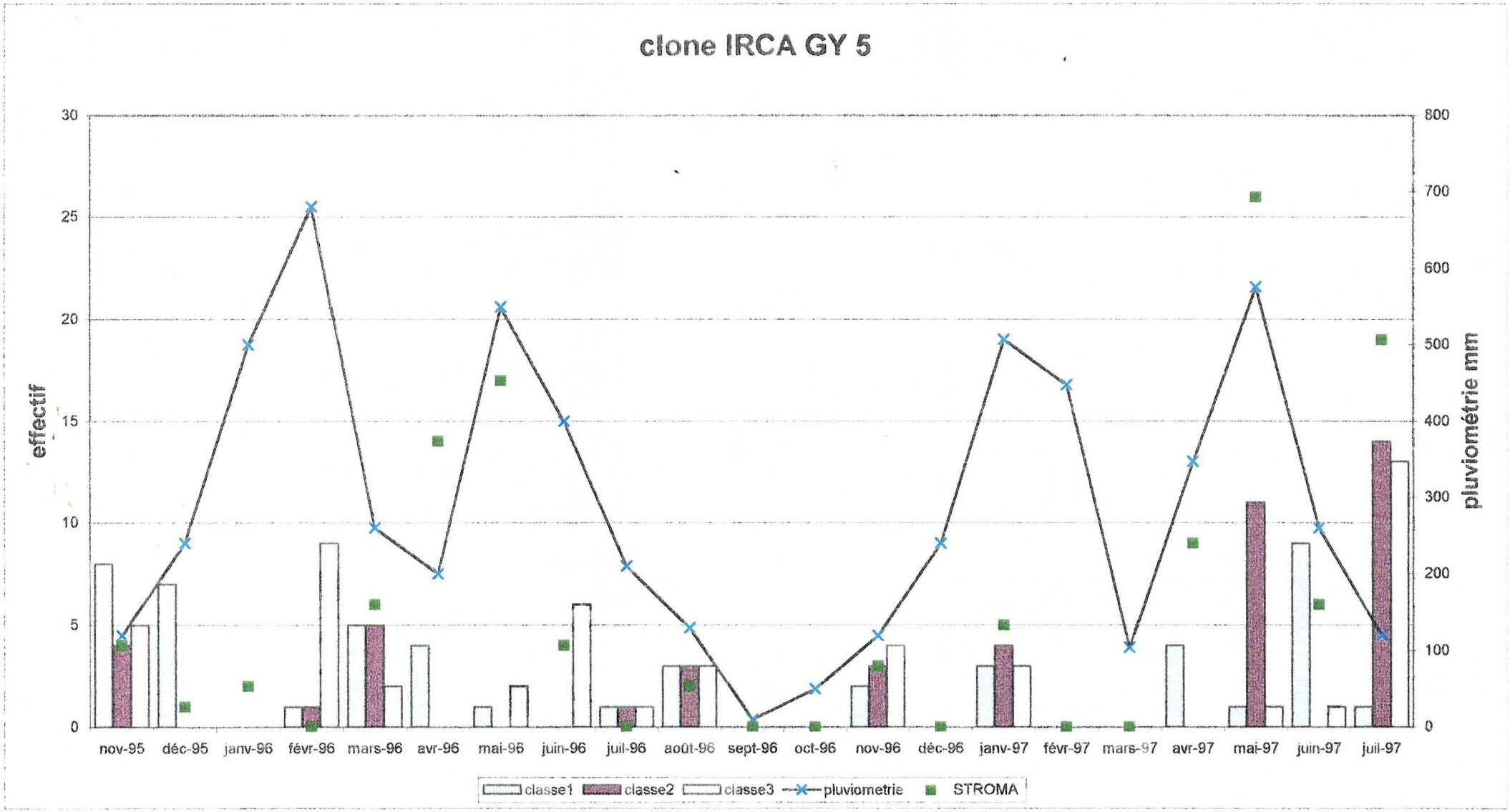

clone IAN 6158
effectif
pluviométrie mm
0
2
4
6
8
10
12
0
100
200
300
400
500
600
700
800
nov-95
déc-95
janv-96
févr-96
mars-96
avr-96
mai-96
juin-96
juil-96
août-96
sept-96
oct-96
nov-96
déc-96
janv-97
févr-97
mars-97
avr-97
mai-97
juin-97
juil-97
classe1
classe2
classe3
pluviometrie

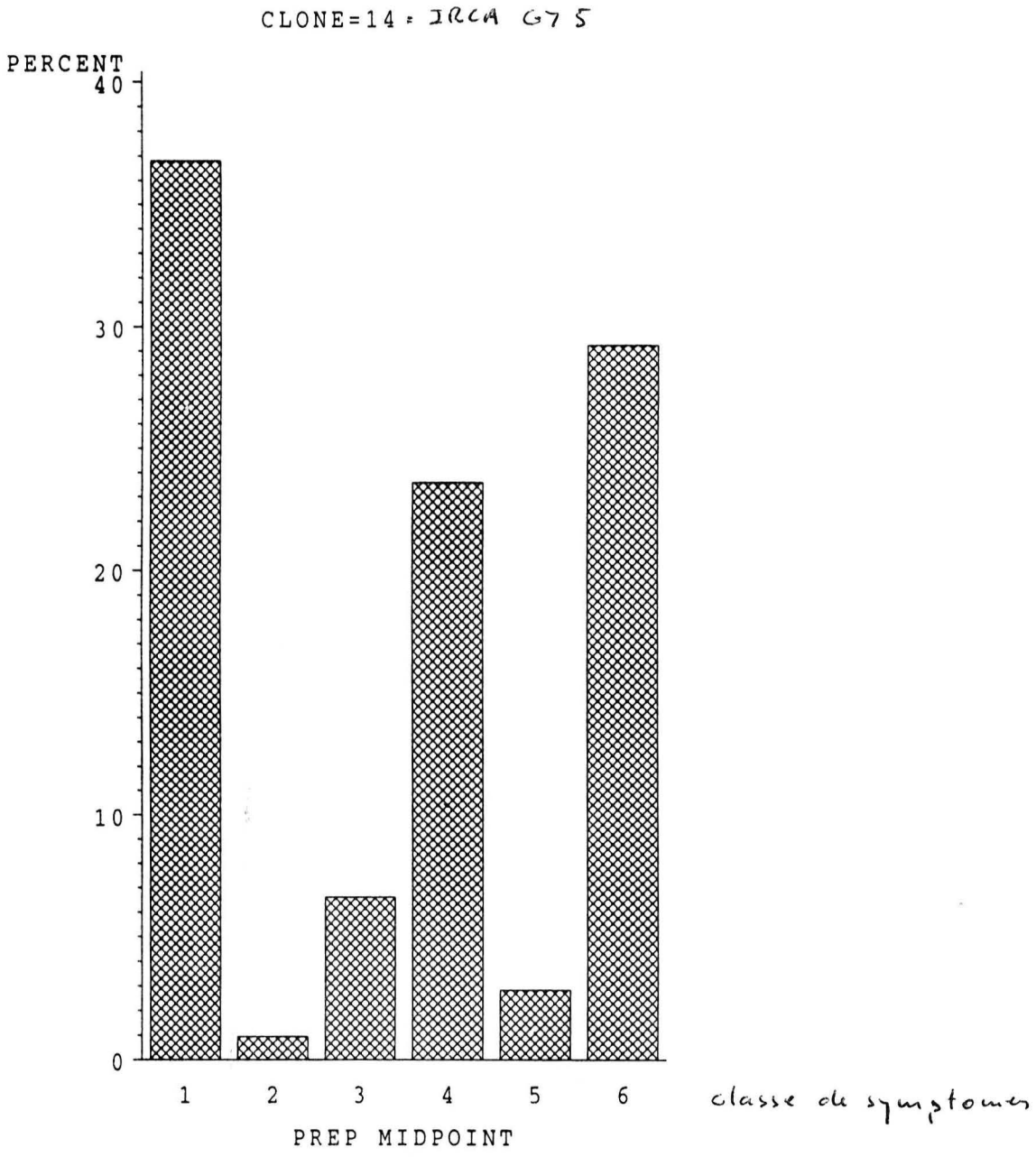

CLONE=8 : IAN 6158
PERCENT
100
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
classe de symptomes
PREP MIDPOINT

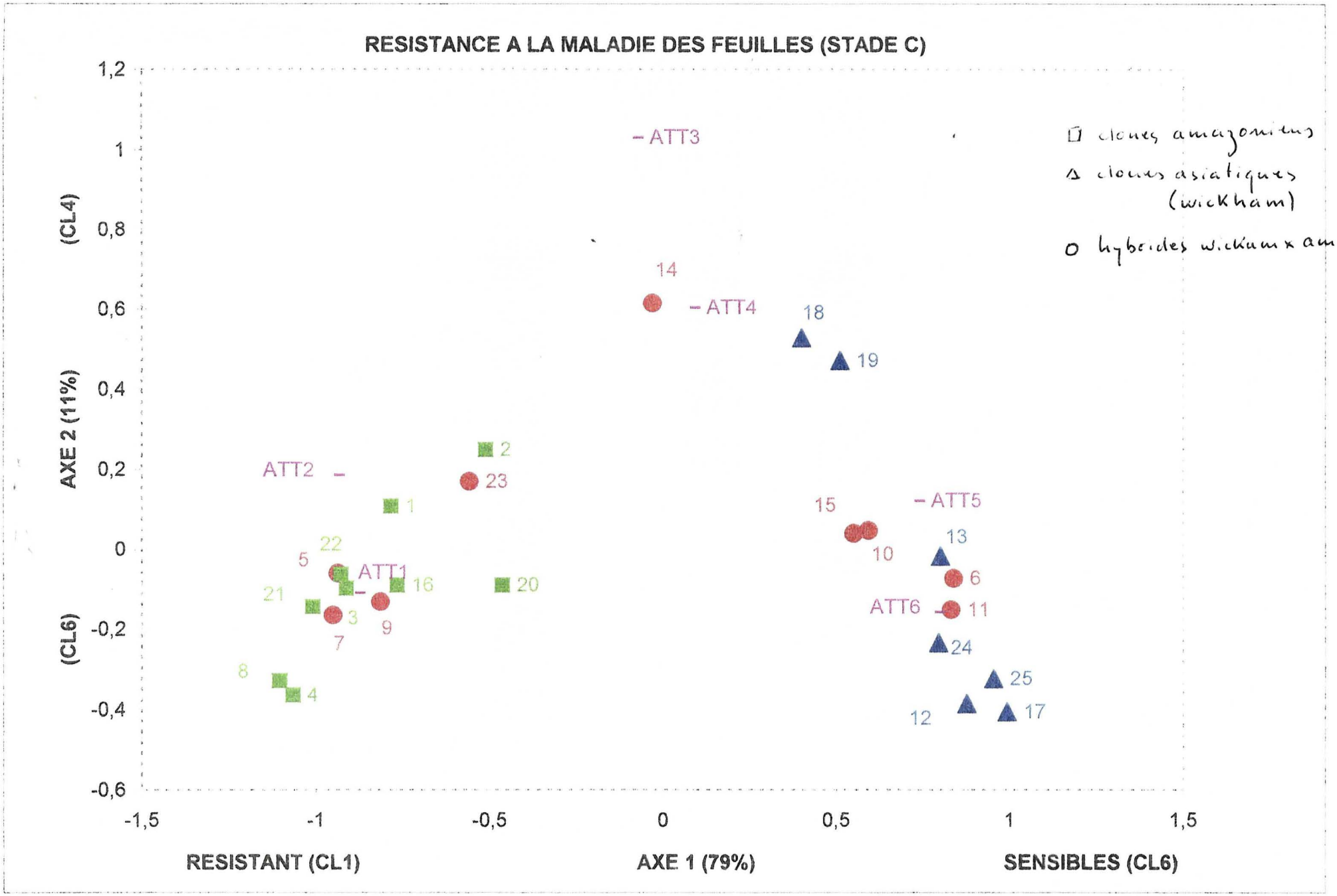

clone RRIM 729
effectif
pluviométrie mm
0
1
2
3
4
5
6
7
8
9
10
0
100
200
300
400
500
600
700
800
nov-95
déc-95
janv-96
févr-96
mars-96
avr-96
mai-96
juin-96
juil-96
août-96
sept-96
oct-96
nov-96
déc-96
janv-97
févr-97
mars-97
avr-97
mai-97
juin-97
juil-97
classe1
classe2
classe3
pluviometrie
STROMA

CLONE=23 : RRin 729




clone IRCA GY 5
effectif
pluviométrie mm
30
25
20
15
10
5
0
800
700
600
500
400
300
200
100
0
nov-95
déc-95
janv-96
févr-96
mars-96
avr-96
mai-96
juin-96
juil-96
août-96
sept-96
oct-96
nov-96
déc-96
janv-97
févr-97
mars-97
avr-97
mai-97
juin-97
juil-97
classe1
classe2
classe3
pluviometrie
STROMA


CLONE=14 : IRCA G7 5
PERCENT
40
30
20
10
0
1
2
3
4
5
6
classe de symptomes
PREP MIDPOINT


RESISTANCE A LA MALADIE DES FEUILLES (STADE C)
AXE 2 (11%)
(CL4)
(CL6)
1,2
1
0,8
0,6
0,4
0,2
0
-0,2
-0,4
-0,6
-1,5
-1
-0,5
0
0,5
1
1,5
RESISTANT (CL1)
AXE 1 (79%)
SENSIBLES (CL6)
ATT3
ATT4
ATT2
ATT1
ATT5
ATT6
14
18
19
2
23
1
22
5
16
20
21
3
9
7
8
4
15
10
13
6
11
24
25
12
17
clones amazoniens
clones asiatiques (wickham)
hybrides wickham x am.

N°	CLONES	GIRTH (cm)	DUNCAN TEST
14	IRCA/GY 5	15,2	
9	IAN 873	14,9	
5	FX 2784	13,9	
16	MDF 114	13,8	
4	F 4512	12,2	
21	RO/JP/3 22/418	11,9	
8	IAN 6158	11,8	
6	FX 3864	11,1	
7	GU 86	11,1	
1	AC/F/6A 36/376	10,7	
23	RRIM 729	10,7	
22	RO/JP/3 22/44	10,2	
13	IRCA 733	9,4	
15	IRCA/GY 7	9,2	
18	RII 118	9	
2	AC/F/6A 36/485	8,9	
3	AC/S/08/40	7,7	
17	PB 260	7,2	
11	IRCA 564	7	
20	RO/JP/3 22/374	7	
10	IRCA 427	6,1	
12	IRCA 617	6,1	
25	RRIM 926	5,7	
24	RRIM 806	5,6	
19	RII 208	5,25	

Selection strategy

1- Select polyvirulent strains of M. ulei, able to infect as many rubber genotypes as possible,

2- Screen Rubber for partial resistance with polyvirulent and agressive strains (wich make possible comparison among clones),

3- Select genotypes with intermediate symptomes (ranking 3 / 4).

Souches	Date	note	IAN 710	FX 4098	FX 3925	MDF 180	FX 985	IAN 3087	FX 3899	IAN 717	FX 25	FX 2804	FX 2261	virulences
pem114	2/6/97	**TR**	6	3.5	5	3	1	4.5	6	4	5	5.5	1	9
pem114p	21/07/97	**TR**	**6**	**6**	**4**	**6**	**1**	**6**	**3,5**	**4**	**6**	**3**	**6**	10
pem114p	15/7/97	**TR**	6	6	4	6	1	4	1	4	6	1	6	8
tri108p	21/07/97	**TR**	**6**	**6**	**4**	**6**	**1**	**6**	**1**	**3,5**	**6**	**3**	**6**	8
tri108p	15/7/97	**TR**	6	6	4	4	1	4	1	4	6	2	*	7*

Marker Assisted Selection to improve resistance to SALB

MAS → more precise
MAS → more rapid

Molecular Markers

- RFLP
- AFLP
- microsatellites
- isozymes

- saturated map

Progeny

PB260 x RO38 ⟶ 200 progenies

- PB260 : high yielding, sensitive to *M. ulei*
- RO38 : low yielding, resistant to *M. ulei*

- description of disease symptoms for each progeny

6 SALB resistance parameters

- incubation period
- fungal generation period
- lesions number
- lesions diameter
- leaf deformation
- reaction type

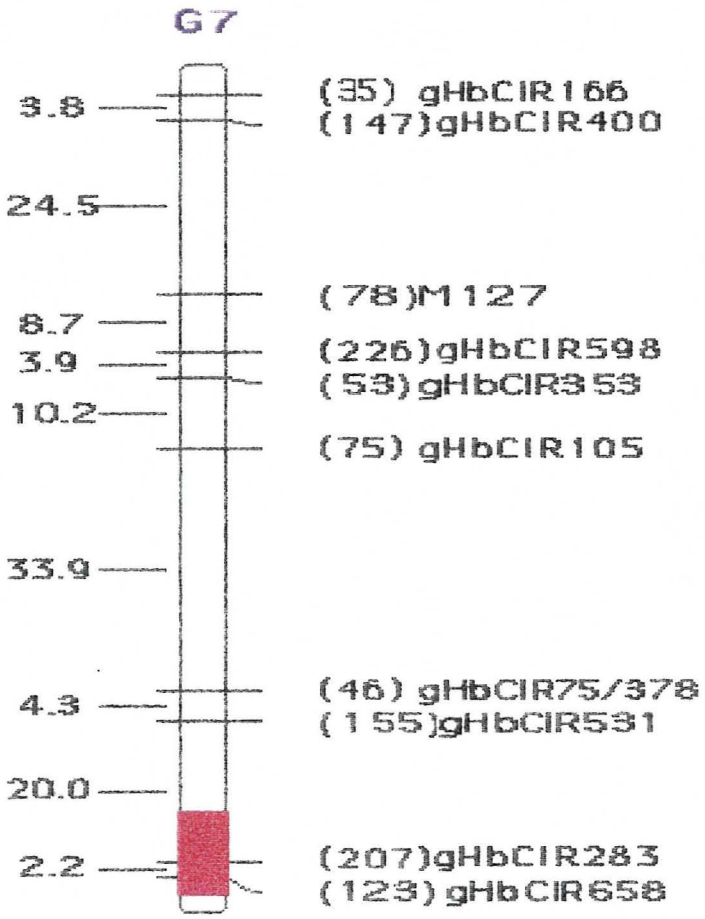
2 *M. ulei* strains

inoculated and analysed in controlled conditions

- G70
- Una 2M

Denis Lespinasse, AGETROP, CIRAD

Example of partial results obtained



Chromosomal region implied in *M.ulei* resistance (G70 and Una 2M)

Results

common regions implied in resistance for two different *M.ulei* strains
several genes, and not one major gene, seem implied in resistance

Improvements

same analysis with more individuals
inoculations with one new strain

Denis Lespinasse, AGETROP, CIR.